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DIRECTIONS FOR INDUSTRIAL USE OF AEROSOLS

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Aerosols are used in many industrial structures to control insects by direct contact or by applying a light deposit of insecticide on the top of exposed horizontal surfaces.

An aerosol is composed of a number of fine liquid particles suspended in the air. It is considered that in an insecticidal aerosol all the particles should be smaller than 50 microns in diameter and 80 percent (by weight) of them should be less than 30 microns. Vapors or smokes composed of particles less than 0.1 micron in diameter are not classed as insecticidal aerosols because they exhibit slightly different characteristics.

Aerosols may be produced by liquefied-gas formulations released through capillary or expansion-chamber nozzles, by steam or air atomization of liquid, by spinning disks and rotors, by forcing liquid under high pressure through atomizing nozzles, by heat vaporization, or by a combination of these methods.

A wide range of particle sizes can be produced, and the size of the particles has a great influence on the effectiveness of the aerosol. The particle size determines the time the aerosol remains suspended in the air and therefore the amount of dispersion by air currents throughout the enclosure. The particle size is a critical factor influencing the amount that collects on an insect as it flies through the aerosol. If the particles are too small, they are deflected from the flying insect as smoke is from a moving automobile, but they will settle out on the insect while it is at rest if the exposure time is adequate. If they are too large, they settle rapidly and their dispersion is poor; therefore their chance of contacting the insect is also poor. When an insect does collide with an oversized droplet, the excess insecticide is wasted.

Settling Rate and Dispersion

Aerosol particles tend to settle vertically at a rate related to their size. The time required for oil particles to settle 10 feet is given below.

Diameter in microns	Time	Diameter in microns	Time
1	26 1/2 hours	20	5 minutes
5	72 minutes	30	2
10	19	50	45 seconds
15	15	100	11

Water droplets settle slightly faster. The lateral dispersion of aerosols is accomplished by air currents after the small impetus from the atomizer is expended. Aerosol particles will not be conveyed into dead-end cracks or into materials through which air does not circulate.

As would be expected, small particles disperse laterally to greater distances than do larger ones, as they are suspended in air for a longer time. In unheated buildings air currents are at a minimum, but heating sets up convection currents that are a great aid to dispersion. In some cases it is necessary to aid dispersion with large-volume air blowers. Table 1 shows the dispersion of aerosols of various particle sizes in an unheated room with a ceiling height of 8 feet.

Table 1.--Lateral dispersion of aerosols of various particle sizes released at the ceiling level in an unheated room 8 feet high

Feet from source	Percent of particles of indicated mass median diameter			
	5 microns	15 microns	25 microns	45 microns
0	28	43	66	84
10	25	40	29	15
20	20	13	4	Trace
30	10	4	Trace	
40	7	Trace		
50	5			
75	4			
100	Trace			

Deposit

About 95 percent of an aerosol settles on the top of horizontal surfaces, and the remaining 5 percent on the walls and ceilings. The amount of deposit on a horizontal surface depends on the concentration of the aerosol directly above that surface. Therefore, if the aerosol is evenly dispersed throughout a room, the deposit will be proportional to the distance of the surface from the ceiling. The deposit on walls and ceiling is mainly on small protrusions, such as fibers, on rough surfaces which catch the particles as they go by on air currents or by settling. Insects resting on the walls and ceiling will also be struck by an occasional particle as it passes by. Surfaces colder than the air temperature slightly attract very small particles.

Selecting Particle Size

No single particle-size range is suitable for all conditions where an aerosol may be used. The particle-size range should be selected after the factors involved in a proposed treatment have been evaluated. The most important factor is time.

If the aerosol is to be applied to a structure or room that can be closed for several hours, small particles will give the best dispersion and penetration into small crevices. An aerosol with particles of about 5 microns mass median diameter was applied in a large warehouse. A thermal generator was operated outside the building, introducing the aerosol through an open door. The aerosol dispersed along the ceiling, and by the time the proper amount had been applied it was well distributed throughout the warehouse by convection currents. The warehouse was then closed overnight and the aerosol allowed to settle. Uniform distribution resulted.

When the treatment must be limited to a short time, larger particles are necessary. A 15-minute exposure is sufficient with an aerosol having particles with a mass median diameter of 15 microns, as most of the particles will settle 10 feet within 5 to 15 minutes. Where flying insects are to be controlled, this type of treatment is quite satisfactory. However, since lateral dispersion is restricted when particles of this size are used, in large rooms or structures the aerosol must be released from several points to give uniform dispersion.

Many types of application will fall between these two extremes. The proper relation between time of exposure and particle size can be calculated from the tabulation on page 2. The allowable settling time should be based on the smallest particles. The approximate distances for uniform dispersion can be determined from table 1. Better dispersion can be obtained when heating sets up convection currents or when fans are used.

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After considering the foregoing factors, the operator can select the most desirable particle size to meet his need, and then the type of generator that will produce the desired particle size and volume of aerosol. If the available equipment will not produce the desired particle size, then the time will have to be adjusted to the size that can be produced.

It has been demonstrated that particles above certain sizes, when composed of some solvents and insecticides used in aerosol formulations, will injure plant foliage. Persons treating greenhouses with aerosols should keep this factor in mind when selecting the particle size.

Some structures may be too open for the successful use of aerosols because of too much loss through the wall openings. In large open warehouses full of tobacco hogsheads, where an aerosol could not be contained in the structures, it was found that a spray with particles of about 50 microns mass median diameter, blown over the top of the hogsheads by a mist blower, gave a uniform deposit of insecticide and good insect control.

Formulations and Dosages

We have used the following formulations and dosages indoors:

1 pound of technical DDT dissolved in 7 1/2 pints of Sovacid 544C (Socony Vacuum) to make 1 gallon, applied at the rate of 1 gallon per 100,000 cubic feet.

1 1/4 pounds of technical DDT and 1/4 pound of lindane dissolved in 3 quarts of tetrachloroethylene plus 1 pint of SAE 50 motor oil to make 1 gallon, applied at the rate of 2 quarts per 100,000 cubic feet.

1 quart of synergized pyrethrum (1-10 mixture of pyrethrins and a synergist) plus 3 quarts of deodorized kerosene and 4 quarts of tetrachloroethylene (proportions of last two materials can be varied to regulate the particle size), applied at the rate of 1/2 to 3 gallons per 100,000 cubic feet, depending on the insects involved.

To prevent explosion hazard, aerosols containing oils should not be applied at rates that will give more than 2 gallons of these solvents per 100,000 cubic feet, and they should not be released near an open flame. All work indoors should be done while wearing a proper respirator. The pyrethrum formula is recommended for use around exposed foodstuffs.

Some formulations contain enough of a relatively nonvolatile oil to maintain the desired particle size while it is suspended in the air.